# Estimating the Volatility of Electricity Prices: The Case of the England and Wales Wholesale Electricity Market

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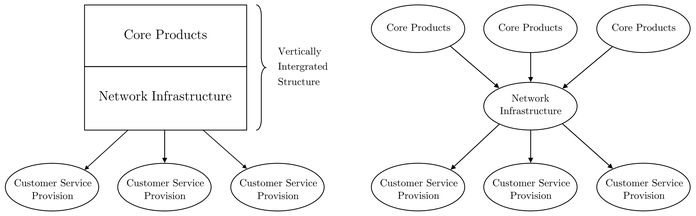
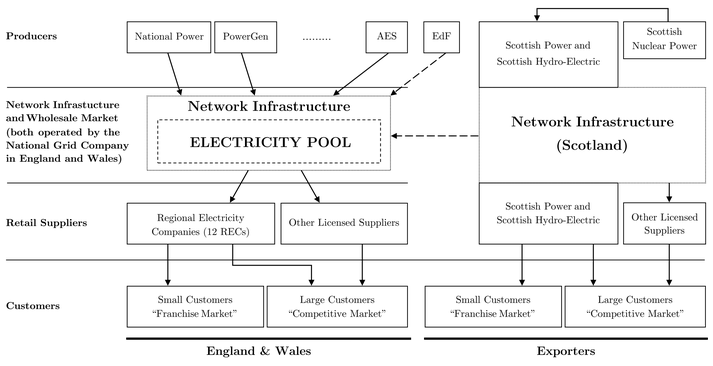
## Structure of a Network Industry before and after Liberalization




(a) Vertically Integrated Case (b) Vertically Separated Case

### Electricity Industry in Great Britain in the late 1990s




## Motivation for the Volatility Analysis

Why do price fluctuations matter?

- uncertainty about revenues and costs
- higher electricity prices for consumers

### Key Questions to Analyze Liberalization

1. Do liberalized markets drive price volatility?
2. How did the institutional changes and regulatory reforms affect the dynamics of electricity prices during the liberalization process?

## Research Approach

- Stationarity: ADF test
- Seasonality: Correlogram and Periodogram based on ACF, PACF, Fourier Transform
- Model Specification: $AR$–$ARCH$ dynamic model with a smoothly time-varying intercept term

## Literature Review

- **Crespo *et al.* (2004)**
  Hourly prices from the Leipzig Power Exchange (Jun 16, 2000–Oct 15, 2001)
  $AR$, $ARMA$ models: separate studies of each hour yielded better forecasts
- **Guthrie and Videbeck (2007)**
  30-min prices from the New Zealand Electricity Market (Nov 1, 1996–Apr 30, 2005)
  Half-hourly trading periods naturally fall into 5 groups, which can be studied separately using a periodic $AR$ model
- **Conejo *et al.* (2005)**
  PJM interconnection data for the year 2002
  Dynamic modeling is preferred to seasonal differencing
- **Garcia *et al.* (2005)**
  Spanish and California electricity markets (Sept 1, 1999–Nov 30, 2000; Jan 1, 2000–Dec 31, 2000)
  $GARCH$ model outperforms a general $ARIMA$ model when volatility and price spikes are present
- **Bosco *et al.* (2007)**
  Daily prices from the Italian wholesale electricity market
  Periodic $AR$–$GARCH$ methodology

## Model Specification

$$price_t = a_0 + \sum_{i=1}^{P} a_i \, price_{t-i} + z_t' \cdot \gamma + \varepsilon_t \tag{1}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-i}^2 + z_t' \cdot \delta \tag{2}$$

$$\nu_t = \frac{\varepsilon_t}{\sqrt{h_t}} \sim \text{GED}, \tag{3}$$

where $z_t$ is a vector of additional explanatory variable (sine/cosine periodic functions and regime dummy variables).

## Methodological Findings

- Application of the sine and cosine periodic functions allow better modeling weekly seasonality
- $+$ and $-$ shocks from the previous week are found to asymmetrically affect volatility

## Policy Conclusions

- The price-cap regulation and first series of divestments are found to result in opposite directions for the movement in the price level and volatility
- During the last regime period was it possible to simultaneously decrease prices and volatility

## References

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